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ANNUAL CONFERENCE ON BIOASSAY (20th), ENVIRONMENTAL, AND ANALYTICAL CHEMISTRY. PROGRAM ABSTRACTS, HELD AT STOUFFER'S INN, CINCINNATI, OHIO, ON 24-25 SEP 1974

National Environmental Research Center
Cincinnati, Ohio

January 1975

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16. ABSTRACT

This volume contains abstracts of the 20th Annual Conference on Bioassay, Environmental, and Analytical Chemistry whose subject matter included measurement, determination, and analysis for radioactivity in the environment, animals, and man. The presentations concerned techniques, methods, instruments, etc., for determining a variety of radioactive substances (e. g., iodine, uranium, Americus) in a variety of situations (reactor stack gases, soil, body tissue, occupational working areas).

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TWENTIETH ANNUAL CONFERENCE

ON

BIOASSAY, ENVIRONMENTAL, AND ANALYTICAL CHEMISTRY

PROGRAM AND ABSTRACTS

September 24, 1974

Stouffer's Inn
Cincinnati, Ohio

Program Chairman: Richard L. Blanchard
Radiochemistry & Nuclear Engineering Facility

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ENVIRONMENTAL RESEARCH CENTER
CINCINNATI, OHIO 45268

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WELCOME BIOASSAY CONFEREES

I wish to extend each of you a hearty welcome and hope that your visit to Cincinnati will be enjoyable. I would like to encourage the wives or husbands who accompanied their spouses to Cincinnati to take advantage of the city's many activities, and I hope that their visit will also be pleasant. As at past conferences, I am certain that we will all benefit from the technical sessions and will leave a bit more enlightened.

If for any reason I can be of assistance in helping to make your stay here more pleasant, please do not hesitate to let me know.

Richard L. Blanchard

TWENTIETH ANNUAL CONFERENCE

BIOASSAY, ENVIRONMENTAL AND ANALYTICAL CHEMISTRY

September 24-25, 1974

Stouffer's Inn
Cincinnati, Ohio

PROGRAM

■ September 23

4:00 - 8:30 p.m. REGISTRATION

■ September 24

8:00 a.m. REGISTRATION

8:30 a.m. WELCOMING REMARKS

Dr. Andrew W. Breidenbach
Director
National Environmental Research Center
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

Session I (8:45-11:50)

Chairman: John H. Harley
Health and Safety Laboratory
U.S. Atomic Energy Commission
New York, New York 10014

8:45 a.m. 1. THE HISTORY OF A NONORGANIZATION

M. F. Milligan
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

9:05 2. RADIOBIOASSAY AND ENVIRONMENTAL MONITORING FOR CARBON-14

A. A. Moghissi and M. W. Carter
Georgia Institute of Technology
Atlanta, Georgia 30332

9:25 3. DEVELOPMENT OF A LOW COST VERSATILE METHOD FOR MEASUREMENT OF HTO AND HT IN AIR

W. E. Sheehan, M. L. Curtis, and D. C. Carter
Mound Laboratory
Monsanto Research Corporation
Miamisburg, Ohio 45342

9:45 4. IMPROVED TRITIUM ACID ELECTROLYSIS SYSTEMS

D. C. Bogen and J. Feldstein
Health and Safety Laboratory
U.S. Atomic Energy Commission
New York, New York 10014

10:05-10:30 COFFEE BREAK

10:30 5. AN EXPERIMENTAL METHOD OF ESTIMATING THE DEPTH OF ^{241}Am DEPOSITED IN THE CHEST

R. E. Toohey
Argonne National Laboratory
Argonne, Illinois 60439

10:50 6. EFFECTIVENESS OF DTPA IN AN AMERICIUM-CONTAMINATED WOUND CASE STUDY

W. P. Walsh
Pacific Northwest Laboratory
Battelle Memorial Institute
Richland, Washington 99352

11:10 7. ANION EXCHANGE SEPARATION OF PLUTONIUM IN HYDROCHLORIC-HYDROBROMIC ACID MEDIA

R. D. Oldham and R. P. Larsen
Argonne National Laboratory
Argonne, Illinois 60439

11:30 8. ANALYSIS OF ^{239}Pu AND ^{241}Am IN LARGE-SIZED BOVINE SAMPLES

W. J. Major, K. D. Lee, and R. A. Wessman
Analysis Laboratories Division
LFE Environmental
Richmond, California 94804

11:50-1:30 LUNCH

Session II (1:30-4:30)

Chairman: S. A. Reynolds
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

1:30 p.m. 9. THE DOSIMETRY OF ^{241}Pu RECONSIDERED

J. W. Poston and W. S. Snyder
Health Physics Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

1:50 10. DETERMINATION OF PLUTONIUM IN BIOLOGICAL TISSUES USING FISSION TRACK COUNTING AS THE METHOD OF DETECTION

R. P. Larsen and R. D. Oldham
Argonne National Laboratory
Argonne, Illinois 60439

2:10 11. SOME EXPERIENCES WITH THE DETERMINATION OF METABOLIZED PLUTONIUM IN EXCRETIONS

J. Sedlet and J. J. Robinson
Argonne National Laboratory
Argonne, Illinois 60439

2:30 12. COMPUTER ANALYSIS OF X-RAY SPECTRA FROM MIXTURES OF ACTINIDE ELEMENTS

C. T. Schmidt
Lawrence Berkeley Laboratory
Berkeley, California 94720

2:50-3:10 COFFEE BREAK

3:10 13. ANALYTICAL STUDIES OF HUMAN LUNG TISSUE

D. V. Sweet, J. V. Crable, and W. E. Crouse
National Institute for Occupational Safety and Health
Cincinnati, Ohio 45202

3:30 14. THE DETERMINATION OF OXYGEN-18 IN WATER BY CHARGED PARTICLE ACTIVATION

R. A. Wood, N. S. MacDonald, K. Nagy, D. Beckman, S. T. Wakakuwa, and H. Kaaz
Laboratory of Nuclear Medicine and Radiation Biology
University of California
Los Angeles, California 90024

3:50 15. MEASUREMENT OF ^{125}I IN THE HUMAN THYROID

H. B. Spitz, R. A. Guilmette, and N. Cohen
Institute of Environmental Medicine
New York University Medical Center
New York, New York 10016

4:10 16. A SPECIFIC HIGH SENSITIVITY DETERMINATION OF I-131 IN MILK

S. H. Daniel, F. L. Bronson, and S. M. Kim
Radiation Management Corporation
University City Science Center
Philadelphia, Pennsylvania 19104

6:00-10:00 RIVER BOAT CRUISE

Arrangements: Alex Martin
Radiochemistry & Nuclear Engineering Facility
National Environmental Research Center
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

■ September 25

Session III (8:30-11:50)

Chairman: Daniel M. Montgomery
Radiochemistry & Nuclear Engineering Facility
National Environmental Research Center
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

8:30 a.m. 17. DISSOLUTION OF REFRACTORY COMPOUNDS WITH POTASSIUM FLUORIDE FUSION AND/OR HYDROFLUORIC ACID

C. W. Sill
Health Services Laboratory
U.S. Atomic Energy Commission
Idaho Falls, Idaho 83401

8:50 18. THE SEPARATION OF URANIUM FROM URINE FOR MEASUREMENT BY FLUOROMETRY OR ISOTOPE DILUTION MASS SPECTROMETRY

I. A. Dupzyk and R. J. Dupzyk
Lawrence Livermore Laboratory
Livermore, California 94550

9:10 19. THE DETERMINATION OF ^{231}Pa AND ITS DECAY PRODUCTS IN URINE

F. H. Ilcewicz and R. B. Holtzman
Argonne National Laboratory
Argonne, Illinois 60439

9:30 20. THE LEVELS OF STABLE LEAD AND LEAD-210 IN NEW YORK CITY

G. A. Welford, R. S. Morse, and D. C. Bogen
Health and Safety Laboratory
U.S. Atomic Energy Commission
New York, New York 10014

9:50 21. LUNG DOSE ESTIMATES FROM NATURAL RADIOACTIVITY MEASURED IN URBAN AIR

I. M. Fisenne
Health and Safety Laboratory
U.S. Atomic Energy Commission
New York, New York 10014

N. H. Harley
Institute of Environmental Medicine
New University Medical Center
New York, New York 10016

10:10-10:30 COFFEE BREAK

10:30 22. AN INTERCOMPARISON OF VARIOUS ANALYTICAL LABORATORIES IN DETERMINING LOW CONCENTRATIONS OF I-131 IN MILK SAMPLES

G. Hamada
Directorate of Regulatory Standards
B. Weiss
Directorate of Regulatory Operations
U.S. Atomic Energy Commission
Washington, D.C. 20545

10:50 23. CONFIDENCE INTERVALS FOR LOW-LEVEL COUNTING

G. L. Tietjen
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

11:10 24. PROPAGATION OF ERRORS

C. W. Sill
Health Services Laboratory
U.S. Atomic Energy Commission
Idaho Falls, Idaho 83401

11:30 25. THE USES OF MINIMUM DETECTION LIMITS IN SAMPLES WITH LOW COUNTS

G. L. Tietjen
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

11:50-1:30 LUNCH

Session IV (1:30-4:30)

Chairman: Paul G. Voilleque
Health Services Laboratory
U.S. Atomic Energy Commission
Idaho Falls, Idaho 83405

1:30 p.m. 26. A SEMI-THEORETICAL APPROACH TO EXCRETION AND RETENTION OF VARIOUS IONS

L. C. Henley and S. R. Bernard
Health Physics Division
Oak Ridge National Laboraoory
Oak Ridge, Tennessee 37830

1:50 27. A REGULATORY STANDARD FOR LIMITING SINGLE INTAKES OF AIRBORNE URANIUM

R. E. Alexander
Directorate of Regulatory Standards
U.S. Atomic Energy Commission
Washington, D.C. 20545

2:10 28. THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION LABORATORY ACCREDITATION PROGRAM

N. E. Whitman
Coordinator for Laboratory Accreditation
American Industrial Hygiene Association
Allentown, Pennsylvania 18103

2:30 29. NEW LIFE IN THE OLD MIAMI ERIE CANAL

W. H. Westendorf, B. Robinson, and L. C. Hopkins
Mound Laboratory
Monsanto Research Corporation
Miamisburg, Ohio 45342

2:50-3:10 COFFEE BREAK

3:10 30. SURVEILLANCE OF A BWR FACILITY SITED IN A POPULATED ESTUARINE ENVIRONMENT

D. E. McCurdy, J. C. Feeney, M. Guttman, and J. F. Ross
New Jersey State Department of Environmental Protection
Trenton, New Jersey 08625

3:30 31. SEQUENTIAL RADIOCHEMICAL ANALYSIS FOR RUTHENIUM, STRONTIUM, AND CESIUM IN ENVIRONMENTAL AIR

H. L. Krieger, E. R. Martin, and G. W. Frishkorn
Radiochemistry & Nuclear Engineering Facility
National Environmental Research Center
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

3:50 32. POTENTIAL INCREASE IN TROPOSPHERIC CARBON-14 FROM THE NUCLEAR POWER INDUSTRY

C. B. Nelson and P. J. Magno
Office of Radiation Programs
U.S. Environmental Protection Agency
Washington, D.C. 20460

4:10 33. ANALYSIS OF CARBON-14 AND TRITIUM IN REACTOR STACK GAS

S. Gold
Radiochemistry & Nuclear Engineering Facility
National Environmental Research Center
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

4:30 CLOSING REMARKS

Dr. R. L. Blanchard
Radiochemistry & Nuclear Engineering Facility
National Environmental Research Center
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

THE HISTORY OF A NONORGANIZATION

Morris F. Milligan
Los Alamos Scientific Laboratory*
Los Alamos, New Mexico 87544

ABSTRACT

The first meeting on Bioassay and Analytical Chemistry is recalled. The aims and subject matter of that meeting are discussed, and alterations in areas of interest and concern since that time are described. The relative advantages and disadvantages of a nonstructured series of conferences such as this are considered.

Emphasis is placed on the facts that sponsorship of each annual conference is voluntary, that no organization has ever assumed responsibility for perpetuation, and that somewhat informal meetings of this type constitute a useful supplement to highly organized sessions of exquisitely structured scientific and/or learned societies.

*Temporarily assigned to Radiological Assessment Branch, Directorate of Licensing, United States Atomic Energy Commission

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RADIOBIOASSAY AND ENVIRONMENTAL MONITORING FOR CARBON-14

A. A. Moghissi and M. W. Carter

Office of Interdisciplinary Programs
Georgia Institute of Technology
Atlanta, GA 30332

Natural environmental levels of carbon-14 have been essentially constant for centuries. During the early part of this century the combustion of fossil fuels reduced environmental carbon-14 concentrations, while latter atmosphenic nuclear weapons testing increased the specific activity of carbon-14. Thus the present carbon-14 level is slightly above the natural concentration.

Nuclear power reactors, in particular high temperature gas cooled reactors, produce carbon-14 which if released could present an environmental hazard.

Methods for radiobioassay and environmental monitoring are reviewed emphasizing four new liquid scintillation techniques.

The first technique consists of synthesis of benzene at levels as high as 20 ml. This method is elaborate and results in high precision values.

The second method is an optimized phenethylamine technique capable of measuring changes as low as 5% in environmental levels.

The third procedure uses sodium carbonate and is particularly suitable for radiobioassay and emergency environmental monitoring.

The fourth technique is based on incorporation of ethanol into the scintillation liquid.

Advantages and disadvantages of these and other monitoring techniques are discussed.

DEVELOPMENT OF A LOW COST VERSATILE METHOD FOR MEASUREMENT OF HTO AND HT IN AIR

Warren E. Sheehan, M. L. Curtis, D. C. Carter
Monsanto Research Corporation
Mound Laboratory*
Miamisburg, Ohio 45342

ABSTRACT

A low cost, highly sensitive method for the measurement of HTO and HT in air has been developed. The air is initially passed through an ethylene glycol bubbler to remove the HTO then through a heated palladium catalyst where the HT gas is oxidized to HTO and collected in a second ethylene glycol bubbler. The tritium collected by the bubblers is measured by liquid scintillation counting. Recoveries of 95 to 100% with air flow up to 750 cc/min are routinely obtained. The sensitivity of the method is basically dependent on the liquid scintillation counter background and the counting techniques employed. Several applications of this method of tritium air sampling are in use at Mound Laboratory and are discussed.

*Mound Laboratory is operated by Monsanto Research Corporation for the U. S. Atomic Energy Commission under Contract No. AT-33-1-GEN-33.

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IMPROVED TRITIUM ACID ELECTROLYSIS SYSTEM

D. C. Bogen and J. Feldstein
U. S. Atomic Energy Commission
Health and Safety Laboratory
376 Hudson Street
New York, New York 10014

ABSTRACT

The current levels of tritium in environmental water samples (~150 pCi/ℓ) have required that the existing acid electrolysis enrichment system used at the Health and Safety Laboratory be modified. The previous enrichment method provided a tenfold volume reduction and about 75% tritium recovery. The modified system is flexible in that various sample volumes (100, 150, or 200 ml) may be processed. An initial sample volume of 100 ml is used and additional sample is added daily (25 ml). The time of electrolysis is considerably shorter than the alkaline enrichment system since the rate of electrolysis is constant at about 1 ml/hr.

Various parameters will be discussed such as: precision of analysis versus electrode surface area, comparison of gravimetric and titrimetric results for volume reduction, tritium recovery versus volume reduction, and the effect of sample evaporation during electrolysis on the precision of analysis.

AN EXPERIMENTAL METHOD OF ESTIMATING THE DEPTH OF ^{241}Am DEPOSITED IN THE CHEST*

R. E. Toohey
Radiological and Environmental Research Division
Argonne National Laboratory
Argonne, Illinois 60439

ABSTRACT

An experimental method has been developed for use with a proportional counter to determine the effective depth of ^{241}Am in the chest of a contaminated subject. Profile scans of the subject with a collimated NaI(Tl) detector revealed a general labelling of the skeleton, in addition to material remaining in the lungs seven years after the inhalation of ^{241}Am. In order to calibrate the counter for the response to the Np conversion L x-rays observed from the chest, the possible contribution from material in the rib cage had to be evaluated.

A series of γ-ray spectra was taken of the scattered and primary quanta from a source of ^{241}Am covered with successive layers of Alderson-Rando tissue - equivalent material. The ratio Rsp of scattered (35 - 45 keV) counts to counts in the 60-keV peak proved to be linearly dependent on the thickness of absorber covering the source and independent of the source-to-detector geometry. The inclusion of bone as part of the absorbing material, as would be the case in vivo, also had little effect.

If all the activity was assumed to be in the lungs, an effective soft tissue thickness could be computed from the subject's height, weight, and chest circumference. This figure took into account both the chest wall thickness and the lower bulk density of lung tissue to estimate the effective amount of absorber present; it was 5.19 ± 0.73 cm.

A measurement of Rsp from the subject indicated an absorber thickness of 4.86 ± 0.49 cm, in good agreement with the estimated thickness. Thus the ^{241}Am in the chest was located primarily in the lungs. The amount of ^{241}Am calculated to be in the lungs from measurements with the proportional counter (0.23 ± 0.03 μCi) agreed well with the results of measurements made with NaI(Tl) crystals (0.24 ± 0.02 μCi).

Since ^{241}Am is commonly present in plutonium to which modern workers may be exposed, this technique is highly relevant to the calibration of in-vivo plutonium detection.

*Work performed under auspices of U. S. Atomic Energy Commission

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EFFECTIVENESS OF DTPA IN AN AMERICIUM-CONTAMINATED WOUND CASE STUDY

W. P. Walsh
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Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352

ABSTRACT

A chronological sequence of events in the subsequent therapeutic treatment of an employee who received an injury contaminated by americium-241 reveals the effectiveness of the chelation agent (DTPA) administered. Examination of the dissected excised tissue shows with remarkable clarity the type of wound as well as the extent of the contamination. Daily collection and processing of urine samples show the apparent effectiveness of the chelation treatments and were used by the physician to indicate the desirability for continuing treatment.

ANION EXCHANGE SEPARATION OF PLUTONIUM IN HYDROCHLORIC-HYDROBROMIC ACID MEDIA*

R. D. Oldham and R. P. Larsen
Argonne National Laboratory
Argonne, Illinois 60439

ABSTRACT

Plutonium can be rapidly and selectively separated from the elements that interfere in its radiochemical determination by the use of hydrobromic acid in a hydrohalic acid-anion exchange separation procedure. Plutonium (IV) and (VI) are adsorbed onto the resin column from 9N HCl, interfering elements such as americium and thorium are washed from the column with 9N HCl, and the plutonium is reduced to plutonium (III) and washed from the column with 11N HBr. Interfering elements such as uranium and neptunium, which are adsorbed onto the column from 9N HCl, are retained there during the HCl and HBr washes.

The decontamination factors for thorium, uranium, and neptunium are 10^3, 10^4, and 10^4, respectively when plutonium is adsorbed onto a Dowex - 1 x 2 column that is 5 cm high and 1.0 cm diam., the column is washed with 15 ml of 9N HCl, and the plutonium is eluted with 10 ml of 11N HBr. The recovery of plutonium is about 90%.

*Work performed under the auspices of the U.S.Atomic Energy Commission.

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ANALYSIS OF ^{239}PU AND ^{241}AM IN LARGE-SIZED BOVINE SAMPLES

by

W. J. Major, K. D. Lee and R. A. Wessman

LFE ENVIRONMENTAL
Analysis Laboratories Division
2030 Wright Avenue
Richmond, California 94804

ABSTRACT

The analysis of environmental levels of ^{239}Pu and ^{241}Am in large-sized bovine samples presents a problem in sample preparation and in the purification of the samples for counting. Also, the different cattle organs, such as muscle, blood, liver, bone, etc., often require special procedure modifications.

Sample sizes range up to 4 kg of muscle and 1.5 kg of bone. The muscle and large tissue samples are ground prior to ashing. The large samples are split between several 2-liter pyrex beakers and decomposed on a hot plate to a charcoal appearance. The ashing is completed at 450^0 C in aluminum foil covered beakers in an ashing furnace. The ashing is done conservatively to outgas the sample without starting grease fires.

The ash is dissolved in nitric acid. Any insoluble residues are dissolved in a teflon beaker by HF-HNO_3-HCl treatment and combined with the dissolved ash. Boric acid is added to complex any excess HF in the solution.

In large samples, such as muscle and bone, the first step is to carry Pu and Am on a fluoride precipitate, primarily CaF_2. Plutonium and Am are separated on an anion column and Pu is determined by standard means. Americium is purified by liquid-liquid extraction with HDEHP followed by rare earth fluoride precipitation while Am is oxidized by persulfate with Ag catalyst and held in the soluble plus six state. Any residual rare earth is removed by absorption and elution of Am (III) from a nitric acid methanol column. Electrodeposited samples are counted on an alpha spectrometer.

Plutonium and ^{241}Am detection limits vary with sample but typically are 10^{-4} dpm/g ash.

An alternate method being evaluated is to replace the Am oxidation step and the nitric-methanol column with a cation exchange column and an anion exchange column in the thiocyanate form.

THE DOSIMETRY OF ^{241}PU RECONSIDERED*

J. W. Poston and W. S. Snyder
Health Physics Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

ABSTRACT

^{241}Pu emits a single beta ray of maximum energy 0.0208 Mev and average energy 0.0052 Mev, and it decays to ^{241}Am which has a radioactive half-life of 458 years. In consequence, the dose due to production of the daughter element within the body is small during a human life span so that ^{241}Pu may be regarded as almost a pure beta emitter with the beta having a very weak energy. This has prompted us to reconsider the dosimetry of this radionuclide. First of all, the ICRP no longer uses the quality factor of 1.7 for low-energy beta rays. The dosimetry of ^{241}Pu in the lungs, liver, bone, and GI tract is discussed. The greatest change in dose is found for the GI tract and is due to the short range of the beta ray which is far shorter than the range of the ^{239}Pu alpha particle, and this has been shown to be ineffective for irradiation of the GI tract. The effect of the ICRP lung model and the estimation of dose to endosteal cells and to the red bone marrow are also discussed.

---

*Research sponsored by the U. S. Atomic Energy Commission under contract with Union Carbide Corporation.

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DETERMINATION OF PLUTONIUM IN BIOLOGICAL TISSUES USING FISSION TRACK COUNTING AS THE METHOD OF DETECTION*

R. P. Larsen and R. D. Oldham
Argonne National Laboratory
Argonne, Illinois 60439

ABSTRACT

The levels of plutonium from fallout in such materials as biological tissues, soils, and water are extremely low and as a consequence it is necessary to process a particularly large sample when the alpha activity of the separated plutonium is the basis for detection. With typical concentrations of plutonium in these materials being about 1, 20, and 0.001 fCi/g, respectively, the sample sizes must be 100, 5, and 50,000 grams to obtain a statistically significant number of counts in a reasonable period of time (24 hours).

An analytical method is being developed for the determination of plutonium in biological tissues in which the method of detection will be fission track counting. Because fission track counting is intrinsically a much more sensitive detection method than alpha counting (the rate of fission track formation in a thermal neutron flux of 3×10^{12} is a factor of 10,000 higher than the alpha count rate), it should be possible to reduce markedly the original sample size or, if the sample size must be large to be representative, the size of the aliquot taken for analysis.

The successful application of fission track counting to the determination of plutonium depends, in the main, on the ability to (1) effect a high decontamination from the uranium in the sample, (2) exclude ubiquitous uranium from the separated plutonium prior to the irradiation and (3) secure materials that have very low uranium contents for mounting the plutonium and for recording the fission tracks. The procedure that will be used to effect the separation from uranium as well as the other constituents of the samples is presented in another paper at this meeting. The materials problem has been investigated and it appears that a detection limit of 0.1 fg (0.007 fCi) can be realized if the uranium content of the mounting and track recording materials proves to be the limiting factor in the analysis. The steps that will be taken to exclude ubiquitous uranium will be discussed.

*Work performed under the auspices of the U.S. Atomic Energy Commission.

SOME EXPERIENCES WITH THE DETERMINATION OF METABOLIZED PLUTONIUM IN EXCRETIONS

J. Sedlet and J. J. Robinson
Occupational Health & Safety Division
Argonne National Laboratory
Argonne, Illinois 60439

ABSTRACT

Our laboratory has recently analyzed urine and fecal samples collected from two individuals approximately 25 years after they received plutonium-239 injections. Both types of samples were analyzed by essentially the same method. After ashing, the inorganic residue was treated with mineral acids, the plutonium coprecipitated from the solution with cerium fluoride, the fluoride dissolved, the plutonium separated on a nitrate anion-exchange column and electrodeposited for counting by alpha spectrometry. Plutonium-242 was used to obtain the chemical yield.

The urine samples gave high chemical recoveries and very thin electrodeposited sources. The recoveries for the fecal samples averaged lower and were more variable, and thicker, though satisfactory, electrodeposits were obtained. Data are presented which indicate that the behavior of both plutonium isotopes was quantitatively the same in the analytical procedure, although the inorganic residue was not always completely dissolved.

By adding plutonium-236 to the samples at various stages of the chemical separations, additional information on chemical losses and on the state of the plutonium were obtained.

Both urinary and fecal excretion rates were readily measurable, and the results are presented. The average urine/fecal excretion ratio over the two-week collection period was 1.52 and 2.57 for the two individuals, respectively.

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COMPUTER ANALYSIS OF X-RAY SPECTRA FROM MIXTURES OF ACTINIDE ELEMENTS

C. T. Schmidt
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Abstract

A study of instrumental analysis of mixtures of actinide elements has been made using a Si(Li) detector. Pulse height spectra from mixtures of ^{238}Pu, ^{241}Am and ^{244}Cm were analyzed with a weighted least squares computer program. To simulate mixtures with components of different intensities, single element sources were counted for several different lengths of time in the same geometry. These single element spectra were then combined by the computer into a simulated "mix" spectrum with component intensities proportional to the known counting times.

The single element sources were prepared to have approximately equal x-ray emission rates and were about 200 nCi for ^{238}Pu and ^{244}Cm, and 50 nCi for ^{241}Am. The absolute x-ray counting efficiency was 5%.

With minimal shielding for the detector, the analysis program was able to detect activities corresponding to less than 1 nCi for 100 minute count times. The criterion for correct analysis was less than 10% error. For mixtures of activity, correct analyses were obtained if the smallest component was about 10% or more of the total activity.

Theoretically, the program gives statistical estimates of the fraction of each element in the unknown, and the associated standard deviation. To study the validity of the calculated standard deviation, a mixture source was counted 20 times and each count analyzed. From these 20 results, a sample standard deviation was calculated and compared to the set of standard deviations from the analysis program. The agreement was reasonable, but the sample standard deviation was slightly less than that calculated. For example, one set of calculated standard deviations had a range of 6.3 to 8.3%, and a mean of 7.4%. The corresponding sample standard deviation was 6.3%.

ANALYTICAL STUDIES OF HUMAN LUNG TISSUE

D. V. Sweet, J. V. Crable, and W. E. Crouse

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1014 Broadway
Cincinnati, Ohio

ABSTRACT

The Cincinnati laboratories of the National Institute for Occupational Safety and Health have long been engaged in a study of the chemical characteristics of lungs from bituminous coal miners, attempting to gain insight into the etiology of coal workers' pneumoconiosis, (CWP), or "Black Lung" disease. The early specimen groups were analysed for dust (total, coal, and noncoal), free silica, and ten trace metals. It was intended that these concentrations would be related to the medical and occupational histories of the subject miners. Strong positive correlations were found between the degree of lung damage from CWP and concentrations of free silica, total dust, coal dust, beryllium, vanadium, and magnesium.

Data on trace element levels in lung tissue was limited. That which is found in the literature was generated over ten years ago and by methodology differing from that used by NIOSH. Therefore, a sampling group of one hundred human lungs, taken at autopsy at the Cincinnati General Hospital, was acquired to develop control data for the program. Full medical and autopsy reports were supplied and interviews with the next of kin in each case were conducted to obtain personal, occupational, and environmental histories for each subject.

The lungs, and the hilar lymph nodes, were analysed for 21 trace elements: aluminum, arsenic, beryllium, bismuth, cadmium, chromium, cobalt, copper, germanium, iodine, lead, magnesium, manganese, mercury, molybdenum, selenium, tellurium, thallium, titanium, vanadium, and zinc. All but mercury were assayed by spark source mass spectrometry. Flameless AA, after combustion and amalgamation, was used for the mercury analysis. In addition the lung tissue was analysed for free silica, dust (total, mineral, and nonmineral), and hydroxyproline.

A regression analysis was performed for each substance assayed, to show relationships between such factors as age, sex, race, selected disease conditions, occupational exposures, and smoking history.

Further work is underway at the present time on a group of coal miners' lungs gathered from Pennsylvania mining communities.

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THE DETERMINATION OF OXYGEN-18 IN WATER BY CHARGED PARTICLE ACTIVATION

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ABSTRACT

A comparator activation method is described for the determination of ^{18}O in water using the nuclear reaction $^{18}O(p,n)$ 110 min ^{18}F. A measure of the 0.51 mev positron radiation from ^{18}F yields a measure of the ^{18}O. The method is simple, requiring no chemical processing of the $H_2{}^{18}O$ other than distillation. The only element commonly found in distilled water that interferes is carbon by way of $^{13}C(p,n)$ 10 min ^{13}N. This interference is eliminated by storing the samples for 2 hr. before counting. The pre- and post-bombardment processing time for 50 samples is approximately 4 hours. Decay points of 20 sec duration are collected over 5 half-lives of ^{18}F, obtaining a minimum of 14 decay points per sample. The ^{18}O computations are made from the decay data by computer analysis using a non-linear least squares regression technique. Water samples of 1.5 - 15 µl can be analyzed for ^{18}O content using the activation technique. The activation method for ^{18}O analysis is comparable in accuracy and sensitivity to similar analysis by mass spectrometry while showing superior precision. The activation method is being applied to the determination of water flux and metabolic rates in free living animals. Because the activation analysis method is much more precise than mass spectrometry, smaller amounts of ^{18}O-labeled water can be used in any particular experiment, and as a result the cost is correspondingly reduced.

In the present paper the method is described and data is presented showing its accuracy and precision.

MEASUREMENT OF ^{125}I IN THE HUMAN THYROID*

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ABSTRACT

The increased use of ^{125}I in diagnostic nuclear medicine has raised some important questions relating to the detection and dosimetry of this nuclide in Man. Since ^{125}I decays solely by orbital electron capture an in vivo detection system designed for measuring low energy photon radiation was employed with a substantial increase in detection efficiency.

Earlier evaluations with the detection system indicate that the minimum detectable measurable activity (MSMA) for ^{125}I was 3.8 pCi for a 10-minute count at the 95% confidence limit. This is a particularly significant result whose magnitude should be considered for deriving an optimum diagnostic dose, i.e., one that will be medically useful while minimizing the associated radiation exposure to the subject's thyroid.

No value for the "maximum permissible thyroid burden" (MPTB) has yet been assigned to this medically important nuclide. The concern about adopting an MPTB rests upon uncertainties relating to the microdosimetry of the Auger and conversion electrons associated with ^{125}I decay.

* This investigation was supported by contract AT(11-1)3382 from the U.S.A.E.C. and is part of a Center program supported by the National Institute of Environmental Health Sciences grant ES00260.

A SPECIFIC HIGH SENSITIVITY DETERMINATION OF I-131 IN MILK

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ABSTRACT

A specific analytical procedure is described for measuring I-131 in milk utilizing chemical separation and purification followed by a beta-gated gamma coincidence counting technique. This system has a Minimum Detectable Activity of less than 0.05 pCi/liter at time of counting.

I-131 simultaneously emits a beta ray of 0.606 MeV maximum energy and a gamma ray of 0.36 MeV. Thus, if the gamma spectrum is analyzed only when gated by a coincident beta pulse, a system of extremely high specificity for I-131 and with an extremely low background is possible.

The iodine is chemically removed from the milk sample and mixed with a liquid scintillator solution. The chemical procedure employed is outlined below:

- A carrier amount of sodium iodide (30 mg I^-) is added to a four liter milk sample and mixed;
- The iodide is removed from the milk by collecting it on an anion exchange resin;
- The iodine is eluted from the resin with sodium hypochlorite(NaOCl);
- Hydroxylamine hydrochloride (NH_2OH HCl) and sodium nitrite ($NaNO_2$) are used to extract the iodine from the aqueous into the toluene phase;
- Sodium bisulfite ($NaHSO_3$) is utilized to convert free iodine to iodide which is back-extracted into the aqueous pahse;
- The iodide is oxidized to free iodine with sodium nitrite and extracted into the toluene phase;
- The chemical yield is determined spectrophotometrically on a small aliquot of the toluene extract. Our average yields for the batch and column methods are 65% and 80%, respectively.
- 2-methylbutene is added to the toluene solution so the iodine will react to form a more inert molecule;

The sample is mixed with a toluene based liquid scintillation counting solution in a polyethelene vial. A photomultiplier tube is placed into the vial in contact with the solution, thus assuring minimum light loss. This portion of the system functions as the beta detector and has a beta efficiency for I-131 of approximately 45%

The entire beta detector assembly is inserted into a well of 4" x 4" NaI(Tl) detector. The counting efficiency for I-131 is approximately 18% with a background of 0.20 cpm. Some difficulties that may be encountered in the chemical processing of the milk to remove the iodide will be discussed.

DISSOLUTION OF REFRACTORY COMPOUNDS WITH POTASSIUM FLUORIDE FUSION AND/OR HYDROFLUORIC ACID

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ABSTRACT

One of the most important--and most neglected--parts of any analytical procedure is the initial decomposition of the sample. Not only must the sample matrix be dissolved but the element sought must be converted reliably to the proper ionic form before chemical reactions characteristic of that element can be obtained. Complete dissolution is especially difficult with the quadri- and pentavalent elements which form very refractory oxides, carbides, etc., particularly after having been heated strongly. For example, the plutonium in the ash remaining from muffling large samples of lung tissue required more powerful methods for its complete conversion to the ionic state than mere dissolution in nitric acid. Fusion with molten potassium fluoride is one of the simplest and most effective methods for dissolution of metallic as well as siliceous refractories because of the stability of the fluoride complexes and the high reaction rates available at 860°C. Inclusion of a small quantity of potassium nitrate even permits rapid and complete dissolution of refractory carbides such as silicon carbide (Carborundum). The cake can then either be transposed with sulfuric acid to a pyrosulfate fusion with simultaneous volatilization of both hydrogen fluoride and silicon tetrafluoride, or with nitric and boric acids to give a nitrate solution free of sulfate. Color slides of the entire process will be shown to demonstrate that the procedure is neither difficult nor timeconsuming as is generally supposed. Sample dissolution with hydrofluoric acid is much less effective but can be used under certain conditions. Alpha spectra of the plutonium fraction obtained from standard plutonium soils after ignition at 1000°C for 4 hours demonstrate the conditions under which complete exchange with ^{236}Pu tracer was achieved using hydrofluoric acid.

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THE SEPARATION OF URANIUM FROM URINE FOR MEASUREMENT BY FLUOROMETRY OR ISOTOPE DILUTION MASS SPECTROMETRY*

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ABSTRACT

A separation method for the determination of uranium in urine has been developed for 1 to 100 μg/liter for a 10-ml urine sample. The basis for this method is a process described by Korkisch and Steffan (1) that utilizes combination ion exchange–solvent extraction (CIESE). Our method uses 10 ml of urine independent of the amount of uranium present. Recovery of uranium through the ion exchange column is ~95% as determined by isotope dilution mass spectroscopy. Recovery by fluorometry varies between 65 and 84%.

A brief outline of the method is as follows, with special emphasis on pre-preparation of reagent HCl and the ion-exchange resin. These procedures remove interfering iron and organic materials, thereby increasing recovery of uranium and other heavy elements.

Reagent HCl, especially that stored for long periods in brown bottles, contains much more iron than the label states. To eliminate the iron, concentrated HCl is put through a large BioRad AG 1 × 8, 100-200 mesh, 15-cm × 1-cm column as needed, and is stored in polyethylene bottles. This purified HCl is the basis for all HCl reagents.

BioRad AG 1 × 8, 100-200 mesh, ion-exchange resin is batch-graded in a counter-flow fluid grader into various fractions with the 30-70 mm/min fraction being used for uranium chemistry. The resin (~250 cm^3) is washed with 2 M NaOH, rinsed with 8 liters of distilled water and converted to the sulfate form with 1 M H_2SO_4. Finally, it is washed with 4 liters of 0.06 M H_2SO_4 and stored. All fractions used for heavy-element separations are treated in this manner. Excess amines and other resin degradation products are removed by this method, resulting in a resin that yields clean, interference-free samples.

Small ion-exchange columns, having a 20-ml reservoir and a 10-cm × 0.6-cm stem, are loaded with about 6 cm of resin (~1 gram). The sulfate form resin is easily converted to the chloride form with 8 M HCl.

A description of the column chemistry, the fluorometry, including the modifications of a Jarrell-Ash fluorometer, and the isotope dilution mass spectrometry will be presented.

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*This work was performed under the auspices of the United States Atomic Energy Commission.

(1) J. Korkisch and I. Steffan. Mikrochimica Acta (Vienna) pp. 253-278 (1973).

THE DETERMINATION OF ^{231}Pa AND ITS DECAY PRODUCTS IN URINE*

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ABSTRACT

Because of the difficulties in determining the separate nuclides in the ^{231}Pa series by whole body counting, measurement of the excretion rates of the individual members of this series is important in making an estimate of the dose to persons with long-term contamination of ^{231}Pa. Presented here is a procedure for sequentially analyzing in urine ^{231}Pa and members of its decay chain, the 18.7-day ^{227}Th and the 11.4-day ^{223}Ra.

After wet-ashing urine with nitric acid, the Pa is preferentially adsorbed onto silica gel, which is then separated from the supernate and the silica removed with HF. The Pa is electrodeposited onto a stainless steel disk by the method of Talvitie.(1) The ^{227}Th is coprecipitated from the original wet-ashed solution with cerous fluoride and the thorium is separated from the cerium by extraction into thenoyltrifluoroacetone (TTA) at pH 2 from a concentrated solution of $AlCl_3$. After back extraction of the Th into strong nitric acid it is electroplated as above. The ^{223}Ra is coprecipitated with 2 mg of $BaSO_4$ which is then slurried onto a planchet. Each of the parent nuclides is then determined by counting in a proportional α-counter or in a solid-state alpha spectrometer. ^{227}Ac, the 22-yr. daughter of the ^{231}Pa, was not tested, but its level may be determined by aging a separate aliquot of the original solution for several months and then analyzing for the newly grown ^{227}Th.

Cross contamination between nuclides was less than 1%. Yields of tracer were about 85 to 90% and were constant to within 5% between runs.

(1) N. A. Talvitie, "Electrodeposition of Actinides for Alpha Spectrometric Determination," Anal. Chem. 44, 280 (1972).

*Work performed under the auspices of the U.S.Atomic Energy Commission.

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THE LEVELS OF STABLE LEAD AND LEAD-210 IN NEW YORK CITY

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ABSTRACT

Because of the interest in the concentration of stable lead in urban environments, this element as well as lead-210 have been measured in food, water, air, urine, blood, and bone samples in New York City. The lead-210 values are related to the stable lead content as specific activity of stable lead. This was found to be approximately 10 pCi Pb-210 per milligram of stable lead for the majority of the different sample types.

These specific activity values will be discussed and related to other available data. Also radium-226 and uranium values for some of the samples will be presented for comparison with lead-210 and stable lead values.

LUNG DOSE ESTIMATES FROM NATURAL RADIOACTIVITY MEASURED IN URBAN AIR

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ABSTRACT

The naturally occurring gaseous radionuclides radon and thoron are present in easily measurable quantities in the atmosphere. These parent nuclides decay to solid alpha emitting daughter products most of which are attached to aerosols that are inhaled and deposited on the bronchial tree. The alpha dose from these daughters is variable and depends upon the short term atmospheric conditions as well as seasonal variations.

Measurements of radon, radon daughters and thoron daughters were performed for a period of two years at the Health and Safety Laboratory in New York City. The measurements of the daughter activities included RaA, B, C, ThB and C and also unattached RaA and ThB. The unattached fraction of radioactivity from RaA and ThB is important in the estimate of bronchial dose since these deposit with essentially 100% efficiency on the upper respiratory tract.

Results will be presented which show the correlation of these measured activities in the atmosphere as a function of time. Dose estimates for basal cells in bronchial epilthelium are computed from long term averages of indoor and outdoor concentrations of these radon and thoron daughter measurements from New York City air.

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AN INTERCOMPARISON OF VARIOUS ANALYTICAL LABORATORIES IN DETERMINING LOW CONCENTRATIONS OF IODINE-131 IN MILK SAMPLES

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The critical environmental pathway of concern in the design and operation of light water nuclear power reactors has been the air-vegetation-cow-milk infant food chain. Appendix I reflects the concern in setting the annual dose limit to the thyroid of any individual exposed to this pathway to 15 millirems. For a number of operating reactors and some under construction, calculations indicate that the thyroid dose to certain susceptible individuals could exceed 15 millirems per year. In order to assure that such doses are in fact not exceeeded, the AEC has required most licensees to be capable of measuring 0.5 pCi/liter at the time of sampling with an overall accuracy of 25%. The AEC has published Regulatory Guide 4.3 to provide licensees with a tested procedure which could accomplish this objective.

Concerns were expressed by a number of groups, however, that routine analysis of I-131 in milk at these levels would not be practicable or even possible. On the other hand, many commercial laboratories are confident that the sensitivity and accuracy requirements can be met.

In an effort to determine the quality of data, on the average, that might be expected from a spectrum of laboratory groups which would or could be involved in such activities, an intercomparison program for analyzing low concentrations of I-131 in milk was initiated by the Office of Regulation. This program was not intended to test the procedure suggested in Regulatory Guide 4.3, but rather to determine the relative accuracy and precision of procedures being used by the various laboratories.

Fifteen laboratories agreed to participate in the intercomparison. These were commercial, State, EPA and AEC laboratories. Initially, an ^{131}I "standard" was provided to each participant in order to calibrate the counting systems. Shortly, thereafter formalin preserved fresh milk samples with a known concentration of radioiodine was sent to each participant. This served two purposes: 1) to uncover any unforeseen problems in the distribution of the spiked samples, and 2) to provide an initial test for those laboratories which were unsure of their ability to determine these low concentrations.

The unknown samples were distributed a few weeks later and were spiked at three different concentrations ranging from 0.5 to 4 pCi/liter. Each participant received two samples of each concentration plus one blank. The spiked samples were prepared in a manner similar to the known samples, i.e., 20 ml of carrier and formalin preservative. The results of the intercomparison are discussed as well as the effect of formalin preservative in passing the raw milk through an anion exchange column.

CONFIDENCE INTERVALS FOR LOW-LEVEL COUNTING

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ABSTRACT

If we have a function $D(X,Y,Z)$ of several independent random variables, X, Y, and Z, then the variance σ_D^2 is approximated by $\sigma_D^2 = (\partial D/\partial X)^2\sigma_x^2 + (\partial D/\partial Y)^2\sigma_y^2 + (\partial D/\partial Z)^2\sigma_z^2$. This process, called propagation of error, is used to obtain a standard deviation on the disintegrations per minute (D) in routine bioassay samples. The standard deviation (σ_D) is then used in constructing a confidence interval ($D \pm K\sigma_D$) for the true dpm in the sample. Applications to real data are discussed, with special reference to low level counting.

PROPAGATION OF ERRORS

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ABSTRACT

There is probably no such thing as a "true" value in the sense of complete absence of bias or uncertainty. Every physical measurement involves uncertainties, not only in itself but also in other measurements that have gone before and on which the current one depends. Measurements can be repeated and refined until the mean can be expected to approximate the "true" value closely, or a "true" value can be defined by acclamation as that value agreed upon by a group of experts in the field of the measurement. For the sake of erring on the conservative side, physical measurements should not be permitted to appear more precise and/or accurate than they really are. Consequently, all uncertainties in all measurements must be examined and the significant ones carried through, or propagated, to the final result. Agreement among replicate analytical results between laboratories or analytical procedures is difficult enough to determine when only real experimental differences are considered without trying to explain apparent differences that are due only to statistical fluctuations in the quantities measured and are not even real. The statistical process by which uncertainties in several independent variables can be combined to give a fairly accurate estimate of the uncertainty in the final result is referred to as the law of propagation or addition of errors. The fundamental law and several specific formulas will be discussed and some examples calculated.

THE USES OF MINIMUM DETECTION LIMITS IN SAMPLES WITH LOW COUNTS

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ABSTRACT

The concept of Minimum Detection Limit is defined, and a method of calculation is explained using the Poisson instead of the Normal distribution. The use of such limits is considered, including the use of values below the limits to estimate the mean and standard deviation. Examples of applications are given, using bioassay data (< 20 counts), and including quality control studies.

A SEMI-THEORETICAL APPROACH TO EXCRETION AND RETENTION OF VARIOUS IONS*

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ABSTRACT

The properties of ions to form complexes and to be absorbed on or in a solid medium are definitely related to the ionic charge and radius of the ion. Hydrolysis can be considered a special case of complex ion formation; one may use either the hydrolytic properties or the ionic potential for a useful basis for comparison of the retention and excretion of different ions, assuming the medium in which the ions exist is exactly the same. Reference man is assumed to be such a medium. A number of excretion curves have been prepared for widely different ions using this technique and the Langham Pu excretion curve as a basis. These curves compare favorably with published curves obtained experimentally.

The equation for excretion in urine of an ion having an ionic potential denoted by i is

$$\text{Exc rate} = 5.54\, t^{-1.82+0.182i}\, e^{-1.42i}\, da^{-1},$$

assuming the power function describes the excretion from and retention in the body. When hydrolysis is assumed as the basis, then the equation is

$$\text{Exc rate} = 1.1\, t^{-0.095-0.047\,pK_h}\, e^{-0.059\,pK_h}$$

where pK_h is the negative log of the hydrolysis constant. The origin of these equations will be discussed.

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*Research sponsored by the U. S. Atomic Energy Commission under contract with Union Carbide Corporation.

A REGULATORY STANDARD FOR LIMITING SINGLE INTAKES OF AIRBORNE URANIUM

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ABSTRACT

A new regulatory standard limiting occupational intakes of airborne uranium was adopted by the Atomic Energy Commission on June 28, 1974. The standard is intended to protect workers against chemical toxicity from soluble mixtures of U-238, U-234 and U-235 in air. The standard stipulates that for any mixture of these radionuclides, the product of the average concentration and time of exposure during a 40-hour work-week shall not exceed 8×10^{-3} SA uCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is given in the regulation as 6.77×10^{-7} curies per gram of uranium. The specific activity for other mixtures of U-238, U-234 and U-235, if not known, is given as:

$SA = 3.6 \times 10^{-7}$ curies/gm U	U-depleted
$SA = (0.4 + 0.38 + 0.0034E^2)10^{-6}$	$E \geq 0.72$

where E is the percentage by weight of U-235, expressed as percent. The technical basis for the new standard is presented in this paper.

THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION LABORATORY ACCREDITATION PROGRAM

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ABSTRACT

I. INTRODUCTION - ADVANTAGES OF ACCREDITATION
   - A. Standard of Performance
   - B. Self-Evaluation
   - C. Peer-Evaluation
   - D. PAT (Proficiency Analytical Testing) Program
   - E. Advantages to those using Laboratory Data

II. HISTORY
   - A. CLIA (Clinical Laboratory Improvement Act) 1967
   - B. Response of AIHA to CLIA
   - C. Partnership of AIHA and NIOSH in Program
   - D. Hiring of a Full-Time Coordinator
   - E. Development of Documents
   - F. NIOSH Training Course on, "Setting Up Industrial Hygiene Laboratory and Laboratory Accreditation"
   - G. Computer Data Processing Project

III. STATUS OF PROGRAM
   - A. Number of Laboratories Involved
   - B. Site Visit Program
   - C. Relationship to other Professional Organizations
     1. Health Physics Society
     2. CDC Laboratory Licensure & Prof. Testing Branch
     3. OSHA Federal and State Operations

IV. THE FUTURE OF THE PROGRAM
   - A. Problems and Prospects for Growth

NEW LIFE IN THE OLD MIAMI ERIE CANAL

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ABSTRACT

All Environmental Monitoring Programs, whether for the radioactive or nonradioactive industry, should include not only air and water but a routine silt and soil sampling program. While there are no meaningful standards for concentrations, the question remains as to what should be done to evaluate an anomaly, as you probably know. This paper discusses the various aspects of a detailed planned approach for evaluating this situation, including not only the technical aspects of sampling, analysis, and data handling, but also the all-important public relations aspect.

In the very beginning, a special task force was set up consisting of a project director, a scientific advisor, and five other members to cover the areas of Engineering, Public Relations, Law, Sampling and Analysis, and Finance. With the assistance of consulting experts, and with the approval of numerous AEC personnel, a specific environmental survey plan was documented. This plan called for over 1300 analyses of soil and sediment in the ditch, ponds, canals, and river near Mound Laboratory. Numerous samples were split with the AEC Health and Safety Laboratory (HASL), Federal EPA, and the Laboratory for Electronic (LFE Environmental) in California, and the results of these duplicates have shown good agreement. Local variability was studied by taking two five-foot core samples, one foot apart at nearly 100 locations. The hundreds of data points were reviewed weekly by a team headed by the Scientific Advisor. The final analysis was aided by a computer. This paper discusses the results of these analyses including local variability, error limits, and estimation of total quantity and distribution thereof.

Probably a more important aspect of a situation like this where there is no real health problem is the communications or public relations. A review of the more significant public relations incidents are reviewed. Finally, the evaluation of the health hazard or lack thereof is reviewed.

* Mound Laboratory is operated by Monsanto Research Corporation by the U. S. Atomic Energy Commission under Contract No. AT-33-1-GEN-53.

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SURVEILLANCE OF A BWR FACILITY SITED IN A POPULATED ESTUARINE ENVIRONMENT

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ABSTRACT

Detailed offsite surveillance of the Oyster Creek Nuclear Generating Station began in 1971 by the New Jersey State Department of Environmental Protection. The primary pathways by which man could hypothetically be exposed to radioactivity emitted from the facility were monitored using low-level sampling techniques. Major efforts during 1971 and 1972 were focused on the evaluation of the dispersion of radioactive aqueous releases to an estuarine environment and of radioactive particulate emissions within a populated coastal setting. Specimens of shellfish, fin fish, algae, aquatic plants, and sediment common to Barnegat Bay were sampled periodically to evaluate the distribution of facility-produced radionuclides. Water from the discharge canal was continuously sampled by a small inexpensive water pump and a forty liter aliquot analyzed weekly for sixteen radionuclides utilizing four radioassay techniques.

High-volume air samplers were positioned at five locations according to the maximum theoretical atmospheric dispersion X/Q values for stack emissions. Gamma-ray emitting radionuclides and radiostrontium concentrations as low as 0.2 to 0.3 fCi/m^3 were measured routinely through the use of a Ge(Li) spectrometry system and radiochemical techniques, respectively. Airborne ^{131}I, ^{60}Co, and ^{54}Mn were measured at several sampling locations at concentrations ranging between 1 and 100 fCi/m^3.

Details of the sampling and radioassay procedures, as well as the interpretation of the data, will be presented.

SEQUENTIAL RADIOCHEMICAL ANALYSIS FOR RUTHENIUM, STRONTIUM, AND CESIUM IN ENVIRONMENTAL AIR

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ABSTRACT

In routine surveillance operations, the radionuclide measurement of air discharged from an operating nuclear facility involves its entrainment on selective filter or absorptive media, and the determination of gross activity concentration. However, a more sensitive technique is required for gross beta activity levels in environmental samples below 0.1 pCi/m^3, when specific nuclide analysis is desired.

Such a procedure has been developed, tested, and evaluated to measure ^{106}Ru at very low concentrations in air collected on glass fiber filters. The procedure which involves digestion, distillation, and precipitation has been tested on environmental samples over the past year and a half. The method has been subsequently modified so that $^{103/106}Ru$, ^{137}Cs and $^{89/90}Sr$ can be measured sequentially on a single air filter with chemical yields of 75%, 80%, and 75%, respectively.

Minimum detection limits have averaged < 0.005 pCi/m^3 for $^{103/106}Ru$, and at least five-fold lower for ^{137}Cs and $^{89/90}Sr$.

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POTENTIAL INCREASE IN TROPOSPHERIC CARBON-14 FROM THE NUCLEAR POWER INDUSTRY

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ABSTRACT

Carbon-14 produced in the operation of nuclear power reactors can be released to the atmosphere during operation or fuel reprocessing. Once in the atmosphere, carbon-14 released as CO_2 enters the CO_2 cycle and is distributed between the earth's atmosphere, oceans, and biosphere. The increase in specific activity from a release of carbon-14 to the atmosphere has been estimated using Machta's model for the CO_2 cycle.

A tropospheric release of 1 MCi would initially add 1.4 pCi/g carbon to the specific activity of carbon-14 in the troposphere. Five years later this would be reduced to 0.5 pCi/g as the initial release distributes among the earth's resevoirs. Forty years later the addition would drop to 0.3 pCi/g. By this time equilibrium between the resevoirs is being approached so that no further major reductions occur.

Projections of potential releases of carbon-14 from the world nuclear power industry indicate that the increase in tropospheric specific activity from these releases could reach 4.6 pCi/g carbon by the year 2020. This value would be about equal to the specific activity resulting from naturally produced carbon-14 which will have dropped to 4.6 pCi/g carbon from the present level of 5.7 pCi/g carbon due to the Suess effect.

ANALYSIS OF CARBON-14 AND TRITIUM IN REACTOR STACK GAS

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ABSTRACT

The analysis of gases from nuclear power stations includes determination of tritium and ^{14}C in several molecular forms. In this procedure, tritium water vapor is collected in a freeze trap; and ^{14}C (as CO_2) is collected by precipitation in bubblers.

Water vapor, hydrogen, carbon dioxide, and methane gas carriers are added to a gas sample. The sample is drawn into the gas analysis system by means of a vacuum pump and is flushed through the system with purified air. HTO is collected in a freeze trap at -80°C; $^{14}CO_2$ is precipitated as barium carbonate with freshly prepared barium hydroxide in a bubbler. Water mist from the bubblers is then removed from the gas stream as the sample passes through a silica gel spray trap. The gas is then passed through the catalytic oxidation chamber, which converts the remaining gaseous hydrogen and carbon compounds to water and carbon dioxide. The water is collected in a second freeze trap and the CO_2 is precipitated in a second bubbler. The water fractions are weighed and then rinsed with dioxane into plastic vials and counted by liquid scintillation. The barium carbonate precipitates are centrifuged, washed, and transferred to stainless steel planchets for weighing. The precipitates are then transferred to glass vials and counted by liquid scintillation as a suspension.

Minimum detectable levels for both ^{3}H and ^{14}C are 0.4 pCi/sample for samples varying in size from 1 cc to 20 liters.

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